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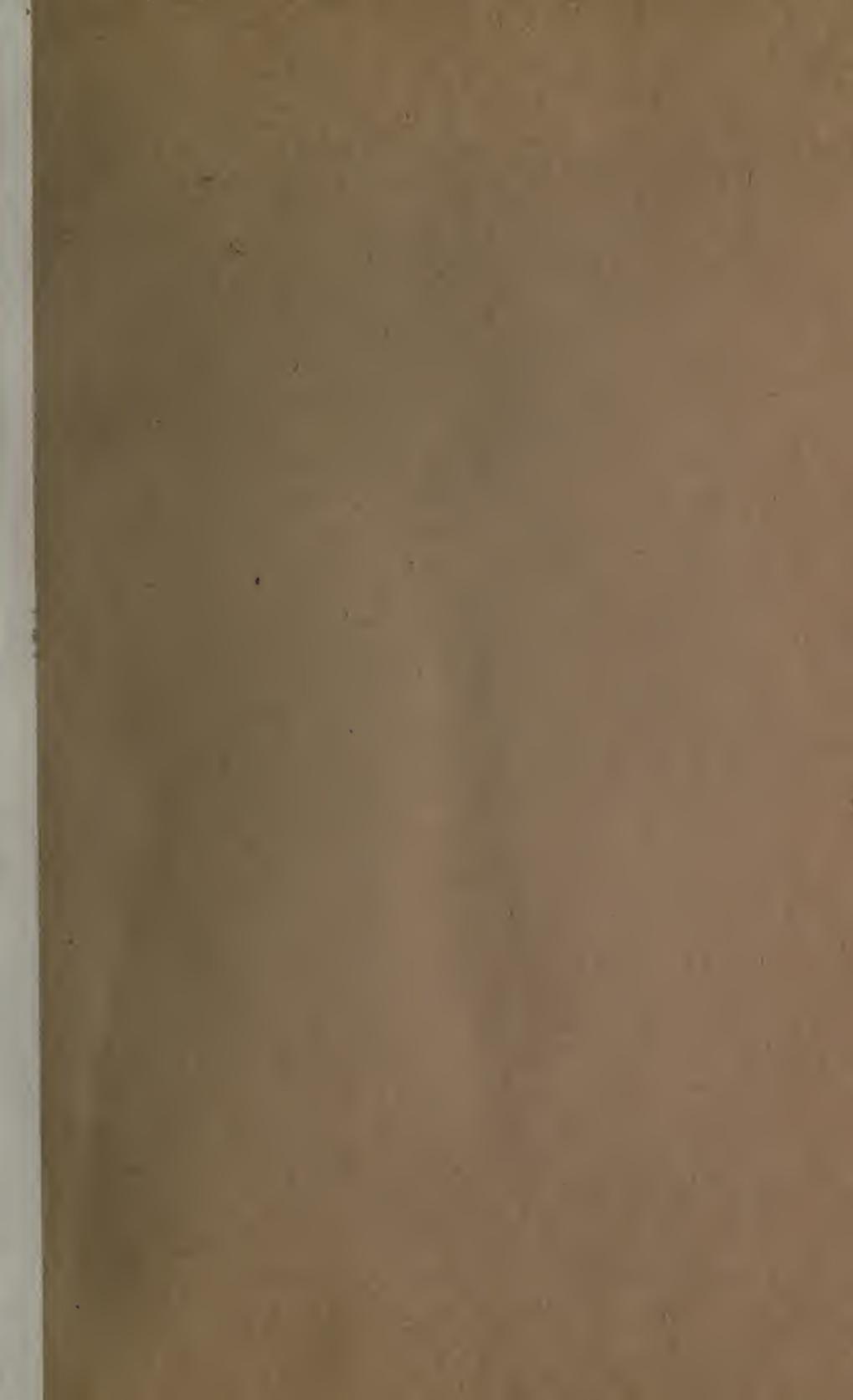
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The Hydrography of the Sacramento Valley

TYPOGRAPHICAL DESCRIPTION OF THE CATCHMENT AREA OF THE INTERIOR BASIN & CONSERVATION OF FLOOD WATERS AND IRRIGATION PROPOSED AS REMEDIES FOR DESTRUCTIVE FLOODS & RECLAMATION OF THE SACRAMENTO AND SAN JOAQUIN RIVER LANDS & &

By WM. H. MILLS
(Originally published in the San Francisco Call)

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California State Board of Trade Bulletin No. 11.

Realizing the great importance of the navigation of the Sacramento and San Joaquin rivers and the drainage of the overflowed region contiguous to them, the California State Board of Trade, in December, 1903, by resolution suggested the holding of a convention at Sacramento to consider these matters. The Sacramento Chamber of Commerce and the Stockton Chamber of Commerce had the subject under consideration, but, no definite action was taken at that time. Later the subject became so pressing that the Sacramento Chamber of Commerce took the matter up and called a State convention at San Francisco, the proceedings of which were made public and the problems involved were assigned to a general committee created by the convention.

The articles herewith written by Mr. William H. Mills, a director of the California State Board of Trade, handles the subject in a most intelligent and comprehensive manner. These merit wide circulation, as they deal with important facts closely related to the problems involved. For this reason the California State Board of Trade produces this bulletin in aid of the inquiry and investigation now being made. These articles first appeared in the San Francisco "Call" on Monday, June 6th, and Monday, July 4th.

CALIFORNIA STATE BOARD OF TRADE,

ARTHUR R. BRIGGS, Manager.

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The Hydrography of the Sacramento Valley



THE catchment area of the San Joaquin and Sacramento rivers embraces approximately 48 per cent of the entire area of the State, or a region comprising about 70,000 square miles.

These two valleys of the Sacramento and San Joaquin may be termed the interior basin of California. From the highest point of watershed on the south to the source of the Sacramento river, near Mount Shasta on the north, the distance in a straight line is about 525 miles. Of this 275 miles belongs to the San Joaquin and 250 miles to the Sacramento. Both rivers constitute the central drainage of a region lying between two ranges of mountains. The Sacramento River, the drainage of the northern portion of this basin, flows south, the San Joaquin River, the drainage of the southern portion of the region, flows north, until they find their confluence on the eastern margin of Suisun Bay. From this point to their outlet to

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the sea, at the west end of the straits of the Golden Gate, they are one river.

The Combined Rivers.

This single river, which flows through Suisun Bay, the lower portion of San Pablo Bay and the upper end of San Francisco Bay to its final point of emptying or drainage into the sea, is without name, being overshadowed by geographical designations in the way of names of bays; but the law of gravitation operates quite unconscious of the names of the lakes or basins through which a river flows. In very truth the west end of the straits of the Golden Gate is the mouth of the combined rivers which flow into the Sacramento and San Joaquin rivers and the Suisun, San Pablo and San Francisco bays, and when all these are taken into account, that is, when the streams that flow into the bays, including the Napa River, Petaluma Creek and the drainage of the Santa Clara, San Ramon and other valleys tributary to the bay system are considered, they form one single river having a catchment area equal to 75,000 square miles, which reaches sea level through the Golden Gate.

The paramount factor, when drainage is under consideration, is the relation of this sea level to the high and low water in the system of bays and the direct influence which this sea level has upon the lower courses of the Sacramento and San Joaquin rivers.

As the American pioneers found this primitive condition, the tide rose and fell every day at Knights Landing, thirty-five miles by the channel of the river above Sacramento, and

the tide influenced the drainage capacity of the San Joaquin as far inland as Stockton. When the Central Pacific Railroad was built, in pursuance of an Act of Congress granting aid for the construction of a railroad from the Missouri River to the Pacific Ocean, Sacramento was accepted as the Pacific Ocean terminus because Pacific Ocean tides were encountered at that point.

A.

While the current of a tidal river is not absolutely arrested, it is obstructed. At high tide in Suisun Bay, there is still a current down the courses of the Sacramento and San Joaquin, but on a higher plane. The rivers rise in response to this tidal influence; and the rise of a river at any given point is referable to one of two causes—either the river above that point has received an accession to its current or its outflow is obstructed below the point. In the case of the Sacramento and San Joaquin rivers, it is known that the daily rise of the river during the drouth period of seven months is referable solely to the obstruction of the tide.

The tides of the ocean, then, obstruct the outflow of the waters of the San Joaquin and Sacramento rivers to a distance of over 125 miles from the mouth of the combined rivers at the western outlet of the Golden Gate. The Sacramento River, opposite the city of Sacramento, has an elevation of 30 feet above sea level, or less than 3 inches to the mile of its course to the sea. The ebb tide through the Golden Gate vastly exceeds the flood tide which flows inward, because it carries outward the water which the tide has delivered to the tidal reservoir composing the bay system and

the accumulated and obstructed waters of the vast catchment area already disclosed.

TOPOGRAPHY OF AREA.

To this point, we have but one side of the story. We have brought to view a river 125 miles in length with an average fall of less than three inches to the mile. We must now consider the topography of the catchment area and rainfall which feeds this river.

The two rivers which flow to the north and to the south and which, turning abruptly west at right angles to their general course, drain two great valleys having the Sierra Nevada Mountains for their eastern and the Coast Range for their western wall, drain these two ranges of mountains to their very summits, and fully 60 per cent, or 42,000 square miles, of their catchment area has an inclination of from 10 degrees to 60 degrees. Upon this unlifted area two-thirds of the entire precipitation of both valleys fall. While this statement is sufficiently comprehensive to those familiar with the facts, for the sake of perspicuity it will be illustrated in detail.

The Sacramento River rises at the north line of Township 40 north, in a straight line, 250 miles by mathematical demonstration from the top of Mount Diablo. From its source to the head of the Sacramento Valley, in a straight line a distance of 48 miles, it has over 3000 feet fall. It receives Fall River, McCloud River and Pitt River as its eastern tributaries, and these rise at an altitude of between 3000 and

4000 feet. They have an average fall of nearly 100 feet to the mile in their entire course.

The annual precipitation in the mountain district, which constitutes the catchment area of the upper end of the Sacramento system, is more than twice the annual rainfall at Chico, and in addition to this the area is subject to phenomenal precipitation, as for instance, five or six inches in from six to ten hours at Delta.

Following the Sacramento on both sides the same condition is maintained. Cow Creek, Deer Creek, Antelope Creek, Mill Creek, Rock Creek, Pine Creek and Butte Creek on the east and Elder Creek, Red Bank Creek, Cottonwood Creek, Toms Creek and Stoney Creek on the west, all in the high altitudes, receive nearly double the annual precipitation of rainfall in their upper courses of that which visits the immediate area of the Sacramento River, and delivers this precipitation, by reason of the inclination of the mountainous district, down channels which make their currents necessarily torrential.

Then the Feather River, two-thirds of whose drainage area stands at an angle of from 15 to 60 degrees, is encountered, and the Yuba and Bear rivers, branches of the Feather River, are practically mountain torrents.

The American River.

Topographical facts relating to the American River will be given in detail as peculiarly illustrative of the situation. The American River has its confluence with the Sacramento River at the city of Sacramento. The mouth of the American

River is in township 8 north, range 4 east. It has three well-defined river channels in township 13 north, range 15 east. The surveys of the Government show that the distance between the mouth and the well-defined sources of this river is but fifty-four miles and these sources are 6000 feet above the mouth of the river.

It is difficult to realize, but it is mathematically true, that a horizontal line fifty-four miles long drawn from the headwaters of the American down to its mouth would stand 6000 feet above the city of Sacramento, and the river channel must take up all of this fall in its course of less than seventy-five miles, even by way of the channel itself. Here is an important tributary of the Sacramento River, having an average fall of eighty feet to the mile, delivering its rainfall and its snow melt into a channel which, from that point to the sea, has less than three inches of fall to the mile.

The upper courses of the American River have more than double the annual precipitation of that recorded at the city of Sacramento. Graphically presented, then, draw two straight lines, one running north 275 miles and the other south 250 miles to a point of junction, where they turn at right angles west to the sea through a single combined channel; then from the high summits of two mountain ranges draw the confluent streams at right angles with the central drainage and with the central axis of the mountains; give these tributaries a declivity of from sixty to one hundred feet fall to the mile and give their catchment areas double the annual precipitation of the lower courses of the main drainage and we have a series of torrential streams delivering flood volumes in a

comparatively few hours into channels which possess the very meager and limited drainage capacity of less than three inches fall to the mile.

B.

Cache Creek and Putah Creek each flow into the Yolo Solano basin, and furnish additional illustration. Cache Creek rises in Clear Lake, thus adding the most of Lake County to the catchment area of the Sacramento River. Putah Creek rises in the eastern portion of Napa County and thus adds nearly one-half of that county to the drainage area of the Sacramento River. From the outlet at Lower Lake to Rumsey at the head of Capay Valley, it is 16 miles, and the river in that district has a 1600-foot fall; through Capay Valley from Rumsey to Capay, 26 miles, the river has 400-foot fall; from Capay to Tule Basin it has 12-foot fall to the mile.

The Inexorable Law of Drainage.

The cross section area of a river-bed must be correlated with the volume of water it is supposed to carry at any given rate of fall. The stream is attenuated down a channel possessing a steep declivity. It is enlarged as the rate of fall decreases and the cross section area of the river must be correspondingly increased to carry its waters within its banks. The cross section area must correspond exactly with the volume of water to be carried and the velocity of the current.

When the accumulated flood waters of all the tributaries of the Sacramento, which, as shown, have their rise in the

high altitudes of two ranges of mountains, the cross section area of the channel of the central drainage must be greatly augmented to compensate for the diminution of the fall.

Applying these principles, the cross section area of the Sacramento River at flood stages can be readily postulated. For the time being, the flood stage is a river and the area it occupies is merely its natural channel or the channel that would be occupied if the flood stage was merely the normal condition of that river.

Tide Obstructs the Current.

When a tide moves eastward through the Straits of Carquinez drainage of the great basin is entirely suspended and, as already shown, there is an obstructing tidal influence for at least one hundred miles up the channels of both rivers. Thus the low stage of Suisun Bay affords all the drainage these rivers can by any possibility have. But the elevation of Suisun Bay is determined by the relation of the sea to the bay system, and the lower courses of the rivers cannot be changed or modified except by a change of the sea level itself.

Owing to the greater rainfall upon the catchment area of the Sacramento, its flood stages are often higher than those of the San Joaquin. The observation of this phenomenon has led to the fallacy of supposing that the Sacramento might be relieved by turning its waters into the channel of the San Joaquin by an artificial canal; that is, invoking the aid of the San Joaquin in the drainage of the Sacramento. But the sea level status of Suisun Bay is the controlling factor when drainage is considered. When the waters of these rivers reach

Suisun Bay they are subject to the same law; therefore, the proposition to empty the waters of one into the channel of the other is attended by the absurdity of supposing that a river may empty itself by delivering a part of its current into its own channel. Both rivers find a common and paramount obstruction in the ocean tides of Suisun Bay.

The meteorological conditions to which the recurrence of great floods in the interior basin are referable are familiar to all the residents of the valleys. One foot of newly-fallen snow is equal to one inch of rainfall, but when ten feet of snow is found it equals fifteen or eighteen inches of rainfall, because the snow has compacted by its weight. When the upper courses of the tributaries of the Sacramento lying from 5000 to 6000 feet above the central drainage of the valley contain from five to ten feet of snow and receive a precipitation of from ten to fifteen inches of rainfall within three days that carries off the snow, the water is delivered to the drainage channels of those tributaries as rain runs off the steep roofs of houses.

Receive the Floods.

The Sacramento and San Joaquin are tidal rivers for nearly 100 miles of their lower courses and must receive these torrential floods and deliver them to the ocean through channels which have but thirty feet fall in 125 miles.

Thus it is that, after an American occupancy of fifty-five years, the problem of drainage remains unsolved. But little has been learned and absolutely nothing has been done to meet the exigencies of the situation. The great flood of the early

50's, the greater flood of February, 1861, and the recurrent great flood of 1904 manifested the same destructive tendencies that would have attended them 100 years ago. They destroyed the island reclamation at the mouths of the Sacramento and San Joaquin rivers, and with it destroyed the engineering theories that such reclamation is not an obstruction to the outflow of the floods. The recurrence of great floods is just as certain as the recurrence of the rainy season.

Uplifted areas like those which constitute more than half the interior basin, must necessarily suffer erosion when the surface of their escarpment is broken by the pasturage of domestic animals and the general occupation of man. This erosion was accelerated by hydraulic and other mining, but it had been in process centuries before California was inhabited and will continue in all the centuries to come. In a comparatively recent period the system of bays extended to the mouth of the Feather River and up the San Joaquin as far as Stockton. In the process of time Suisun Bay will be filled and the Sacramento and San Joaquin rivers will flow through one well-defined channel into the Straits of Carquinez and thence to the sea.

Chapters of Failures.

The history of engineering experiment and theory presents merely chapters of failures. Engineers were found to approve of the drainage act under which an attempt was made to impound the mining detritus by the construction of brush dams. The distinguished engineer James B. Eads was brought to the State for the purpose of bearing testimony in

favor of the practicability of that scheme. He gave a very reluctant assent, saying that the experiment was worthy the trial, but the experiment merely demonstrated the utter fallacy of all the theories concerning it. Two hundred and fifty thousand dollars of State money was expended to make this one experiment. The channel of the Yuba, a high altitude tributary of the Feather River, was selected for the experiment. The first flood destroyed the works that had been erected for its control, with an imperious disregard for engineering theories.

The Sierra Nevada tributaries of the Sacramento and San Joaquin rivers have a velocity of current which makes it impossible to check arrest or impound their waters in their channels. The force of ten thousand cannon balls would be feeble in comparison with the torrents which sweep with destructive velocity down these streams. A stone dam anchored to the bedrock might be constructed to stand, but the reservoir area would fill up the first season and the detritus which results from the perpetual erosion of the mountain declivities would simply fall over the top of the dam and possess no economical value unless for creating electrical power.

Remedy Is Proposed.

It would be merely quoting the opinion of engineers to say that the only remedy for this is the storage of the flood waters of these streams. All of the tributaries of the two drainage channels of the valleys might be economically stored when they reach the general level of the plain below, while up the mountain courses of many of these streams there is

ample opportunity for holding back the flood waters and feeding them into the main channels at a rate consistent with their drainage capacity. In the course of time this will be done. In the natural course of events the Sacramento and San Joaquin valleys will be irrigated and irrigation uniformly destroys rivers.

The Government of the United States has entered upon a scheme of arid land reclamation by irrigation, as relates to the Colorado River, which will destroy the navigability of that stream. It has already assumed the position that the superior public uses of the Colorado River is irrigation, and not navigation. Water sufficient to irrigate the great interior basin of this State must necessarily be stored. The summer stages of all the streams, which when combined create the Sacramento and San Joaquin rivers, are not equal to the demand for the irrigation of these great valleys. When the aggregate precipitation of common years is accumulated by storage and devoted to the fertilization of the Sacramento and San Joaquin plains, the flood stages of the Sacramento and San Joaquin will disappear.

Combination of meteorological conditions will create floods at wide intervals of time, which will be more or less destructive, but the usual condition will be full channels all the year round attended by navigable conditions of the highest economic value. That this result will be achieved is inevitable and the force that will bring it into being is the obvious values to be developed by the undertaking.

The task of impounding the flood waters of the streams supplying the great interior water ways appears stupendous

only to those who are unfamiliar with precedent. We stand appalled before the vast sums of money required for its accomplishment, but the magnitude of these sums sinks into comparative insignificance when measured by the stupendous aggregate of value to be created and the vast populations hereafter to be sharers in the invaluable benefits.

In further discussion of the important subject of the reclamation of the Sacramento and San Joaquin river lands, Mr. Mills says:

Public policies are founded upon the ascertained knowledge and the most cogent reasons influencing determination in the minds of men at the time of their adoption. Later, when the knowledge is becoming obscure and the argument which prevailed in the adoption of the policy is forgotten, the policy is often summoned to the bar of public opinion for a new hearing and determination. Because human judgment is not infallible the unexpected is the only thing that is certain to happen, and since all human institutions are impeachable, it is eminently proper that their wisdom should be reviewed in the strong light of experience.

It is sometimes unfortunate that the assault upon an established policy is led by persons who are unfamiliar with the history of legislation relating to such policy, and who, with that intrepidity which attends insufficient information, become the proponent of methods once fully investigated or tried and condemned.

Policy of Reclamation.

The reclamation policy of California is just now under-

going preliminary impeachment preparatory to the introduction of proposed reforms. A review of the policy now proposed and a presentation of the relations it bears to the history of legislation cannot be devoid of popular interest.

The proposed changes in the policy of reclamation may be summarized as follows:

"1.—To abandon the policy of reclamation by districts or other economic consideration relating to the relative reclaimability of land and resort to reclamation by a single system in which all the swamp lands shall be assessed equally for the reclamation of all.

"2.—To this end it is proposed that the State shall resume control of all swamp land, whether reclaimed or unreclaimed, levying a special assessment on the reclaimed swamp land of the State in the interest of reclaiming all of the swamp land.

"3.—To levy a general annual tax upon all property in the State for a period of ten years and ask the Government to co-operate for an equivalent sum for the same period.

"4.—To estimate the cost of a complete reclamation system, including the rectification of river channels, the construction of additional channels for the relief of flood waters, and after subtracting the sum contributed from the general taxation on all property of the State and the contribution of the Federal Government, to assess the remaining cost for this general reclamation upon all the lands of the district regardless of relative benefits."

Disregarding general details, these four propositions outline the reformed policy now proposed.

Story of the Grant.

By Act of Congress, approved September 28, 1850, the State of California received approximately 1,500,000 acres of swamp and overflowed lands. The act itself declared that the donation was made "to enable the several States to construct the necessary levees and drains to reclaim the swamp and overflow lands therein." The Act then proceeds to declare:

"It shall be the duty of the Secretary of the Interior to make accurate lists and plats of all such lands, and transmit the same to the Governors of the several States in which said lands may lie, and at the request of the Governor of any State in which said swamp and overflow lands may be, to cause patents to be issued to said State therefor, conveying to said State the fee-simple of said lands.

"The proceeds of said lands made from sale or by direct appropriation in kind, shall be applied exclusively, as far as necessary, to reclaiming said lands by means of levees and drains."

The foregoing excerpts present the letter of the law. It is of the highest importance that the terminology employed should have careful consideration.

The first paragraph quoted declares that the Secretary of the Interior shall make lists and plats of the lands and at the request of the Governor of any State, shall cause patents to be issued to the State, "conveying to said State the fee-simple of said land." The statute itself plainly declares that the patent issued by the Government of the United States

shall convey a title in fee simple and this is the full equivalent of declaring that the title is passed by the patent without condition.

But the second paragraph quoted enjoins upon the State the policy of applying the proceeds derived from the sale of the land to the reclamation of the lands themselves by the construction of levees and drains.

Provision Not Mandatory.

The provision that the proceeds of the sale should be applied exclusively, so far as necessary, to the reclamation of the swamp lands was advisory and not mandatory. This statement must be accepted as conclusive since the act itself declares that the Government patent conveys "to the said State the fee simple of the land." Any reservation or exception on the part of the Government was necessarily cut off by the issue of the patent, while at the same time it may be freely admitted that the whole transaction has the color of a grant for purposes of reclamation. This is, however, not to be construed as a declaration that such reclamation is a condition precedent to the receipt of title or that the failure to reclaim shall work a forfeiture of such title.

The State was admitted to the Union of States on September 9, 1850, and the act in question was passed September 28, 1850, when the State was only nineteen days old.

If the obligation of reclamation arbitrarily accompanied the gift the propriety of its acceptance would have been debatable, if not wholly inadvisable. The conditions attending the swamp lands granted were wholly unknown. The

economic value of the grant itself was equally unknown. Hence the people of California could not have known whether the acceptance of the grant accompanied by an arbitrary obligation to reclaim all the lands granted would not be the assumption of a task the fulfillment of which would be wholly uneconomic, if not impossible.

No Time Limit Made.

There was no declaration in the law and no possible inference to be derived from it imposing upon the State the duty to reclaim the land within a given time or to reclaim all of the swamp and overflowed lands granted. On the contrary, it was clearly within the province of the State to proceed with such reclamation in such a manner as to accomplish the ultimate result at such time and in such way as would be most advantageous to the State itself.

The first Act relating to swamp land was approved May 1, 1851, eight months after the date of the Act granting the land. This Act granted 640 acres of swamp land on Merritt Island to John F. Booth and David Galloway, and provided that they should reclaim the land, bring it under cultivation and report the result to the Legislature. The cautious and conservative wisdom of this Act will be apparent.

From this beginning, which related merely to an experiment with 640 acres of swamp land very easily reclaimable, the subject occupied legislative attention at intervals until 1868, when the general Act which to-day constitutes the frame-work of the State swamp land policy was enacted.

The policy underlying this Act was evolutionary. It was

the suggestion of legislative experiment beginning with the Act quoted, and rising through the Acts of April 25, 1855, April 21, 1858, April 18, 1859, May 13, 1861, April 27, 1863, and April 22, 1866. Each of these acts underwent preliminary discussion in the public mind and parliamentary examination by the Legislature. Leading up to the Act of 1868, the entire question of swamp land reclamation was made the subject of thoughtful examination and public advocacy by the very best minds the State has ever produced.

The suggestion of combining all the swamp land into one reclamation district and pursuing a system of reclamation that would distribute the burden of its cost to each acre of swamp land alike, regardless of the relative reclaimability of the land, is now brought forward as an original suggestion, whereas it was advocated and traversed until not one grain of wheat was left in the thrice-threshed straw.

Experience Is Cited.

The experience of reclamation in older countries was appealed to and the lesson of such experiment was read into the current discussion of the time. The policy of attempting a complete reclamation of all swamp lands by placing the ultimate value of all such lands behind the enterprise was rejected, because then, as now, the data upon which the economic value of the policy could be determined was wholly wanting. There was not then and is not to-day sufficient information concerning the cost of reclamation by that plan, or the economic value of the result, to justify the undertaking.

The granting act required the Secretary of the Interior to

make an accurate list and plat of all the swamp lands and transmit these plats to the Governors of the States being beneficiaries of the grant and upon the request of such States, to issue patents conveying the title in fee-simple. This had not been done when the people of California addressed their attention seriously to the question of reclaiming these lands in good faith and of adding their areas to the productive wealth of the State; and the requirements of the law have not yet been fully accomplished.

The knowledge of the subject was general, not specific. It was well known that the lands were divided by their physical condition into five natural classes:

"1.—Lands overflowed at extreme flood stages of the rivers and covered with water for a period so short as to be beneficial rather than injurious and to be practically a substitute for annual irrigation.

"2.—Lands overflowed but a short period in each year and at medium flood stages of rivers; reclaimable at small cost and possessing high intrinsic value after reclamation.

"3—Marsh lands on the margin of tidal reservoirs comprising the bay system, economically reclaimable and highly valuable when reclaimed.

"4—Swamp lands lying within a single hydrographic system, comprising all the grades of relative reclaimability, but more economically reclaimable by treatment as a system than in separate parts.

"5.—Lands wholly irreclaimable by any other method than an absolute control of the entire hydrographic phenomena of the interior basin of the State."

Revenue Lacking.

The cost relating to the reclamation of this fifth class was far beyond the financial possibilities of the time. The only inducement to the reclamation of any of the land was the value of the land after its reclamation. There was no source of revenue available for this purpose. The legislative experiments prior to 1868 had demonstrated this fact beyond all controversy. The appeal to State or Government aid was wholly impracticable. The State was not in a position financially to enter upon the cost of reclaiming all its swamp land property in one general scheme of reclamation, because it was apparent then as now that the cost of such an undertaking would exceed \$100,000,000, while the assurance which would have proffered a request to the Government to add its munificence by reclaiming the property it had presented to the State had not reached the stage of pauperizing dependence it has attained in recent times.

Mining was the paramount industry of the country and the hydraulic method was in full operation. Hydraulic mining was charging the tributaries of the Sacramento and San Joaquin rivers with detritus, which was being forced down the channels of these tributaries on a declivity of 100 feet to the mile and into a central drainage having less than four inches to the mile. The detritus thus forced into the channel of the main streams must necessarily lodge, and the time at which the Sacramento River in particular would wander at will over the alluvial bottom land of the valley could not be foretold.

All commercial and industrial activities, including agricul-

ture, horiculture, manufacturing and merchandise, were then merely subordinate and allied industries to mining. The absence of rail communication with the East had denied an Eastern market for the field, orchard and vineyard products of the State. Hence the proposition of arresting the destruction of the valley by enjoining hydraulic mining had not been dreamed of.

The rapid filling up of the main channel of the central drainage constituted a menace to successful reclamation. The danger was apparent that the river beds would fill up, that the flood maximums would rise, that reclamation levees would have to be increased in height and that vast quantities of mining detritus would be imposed upon the valley lands.

The Only Inducement.

The State was confronted with the condition, which had been fully demonstrated by experiment, that the value of the land when reclaimed was the only inducement to its reclamation. It therefore entered upon the reclamation of that which was most readily and economically reclaimable, leaving the more costly work of reclamation to a time when alluvial deposition, which was then and is now steadily in progress, would make the problem of reclamation more easy, when, by reason of the growth of the commonwealth and the greater density of its population, the land reclaimed would possess a higher value.

During the discussion which was the Genesis of the Act of 1868, it was proposed by some of the very best minds of the State to adopt the mound system of reclamation in use on the

lower course of the Nile. The late B. B. Redding, to whose patriotism and intellectual breadth this commonwealth is still under obligation, was the leading proponent of this plan.

The wisdom of the Act of 1868 has been fully demonstrated. Since the enactment of that law, the swamp land policy of the State has been the subject of legislative attention, as the acts approved on the following dates fully attest: March, 16, 1872; March 28, 1872; Congressional Resolution, 1878; March 29, 1878; April 1, 1878; April 23, 1880; March 24, 1893; March 17, 1897; March 2, 1901, and March 16, 1901. Notwithstanding these acts, the general policy underlying the Act of 1868 has not been changed in any essential feature.

Reference has already been made to the fact that no one possesses sufficient information on the subject to determine, even with a remote probability of accuracy, the economic value of a reclamation scheme having for its object the reclamation of all the overflowed lands belonging to the State. But beyond this, the question of the practicability of the scheme from its legal aspect is worthy of thoughtful consideration.

Question of Legality.

More than 1,200,000 acres of land granted to the State of swamp and overflowed land have been granted to individuals by patent which conveys the title without conditions. These lands, notwithstanding they belong to the category of swamp and overflowed lands, are as completely exempt from special

assessment for the reclamation of other lands as any other lands of the State.

The decision of the Supreme Court in the case of Kimball vs. Reclamation Fund Commission, by superficial reading, would seem to hold that Congress had by the Act granting swamp and overflow lands to the State imposed upon the grant itself the condition that the lands be reclaimed. What the court decided was that, whereas the Legislature had inaugurated a system for the reclamation of these lands by organizing a Board of Commissioners who were to superintend the work, and had provided that in any district where a petition representing one-third in acres of the tract of land proposed to be reclaimed was located, the appellant was bound in law to take notice of the public statute and must be deemed to have accepted the title in subordination of the paramount right and duty of the land to be reclaimed; that a general system for the purpose of reclamation had been inaugurated and that wherever under the provisions of the law the practical measures of reclamation had been set up the owners of land within such district must submit to assessment for the reclamation of the land they owned; that the owner of lands in a district to be reclaimed could not decline to contribute to the cost of such reclamation and then enjoy the increment which would ensue, but must contribute equally with other owners, in the same district to the reclamation cost.

But this is far from declaring that the owners of swamp land which has been reclaimed, who have received patents from the State conveying a title without conditions, may now be subjected to assessments upon their land for the purpose

of reclaiming swamp land which they do not own.

Rulings of the Courts.

It has been claimed that whoever accepts title to swamp land accepts such title in subordination to the paramount right and duty of the State to cause the land to be reclaimed by any method it might see fit to employ. If this contention had been understood to be true, the liability of expenditure on account of the reclamation of any swamp land purchased from the State would never cease until the last acre of swamp and overflowed land had been reclaimed. If this doctrine had been promulgated and believed in from the first, the State would never have parted title with one single acre, because, while the economic value of reclaimed portions of the swamp land might be ascertained, the profitableness of reclaiming it all at the expense of all was wholly unascertainable. No one would have attempted the reclamation of a portion of this land with the understanding that he was eventually to be charged with a proportionate cost of reclaiming all the other swamp and overflowed lands of the State.

But the fact that the swamp lands purchased from the State are not charged with the duty or obligation to reclaim other lands is no longer debatable or doubtful. Whatever construction the decisions of the State court in this relation may be susceptible of, the decisions of the Supreme Court of the United States with reference to the meaning of the Act granting swamp and overflowed lands to States are not ambiguous and obscure.

In deciding the case of *Mills County vs. Railroad Companies*, 107 U. S., 557, it was held:

"The proviso of the second section of the Act, that the proceeds of the lands shall be applied exclusively, as far as necessary, to the purpose of reclaiming the same by levees and drains, imposed an obligation which rests upon the good faith of the States. No trust was thereby attached to the lands, and the title to them, which is derived from either of the States, is not affected by the manner in which she performed that obligation."

And again, in *Hagar vs. Reclamation District*, 111 U. S., 701, it was said:

"It is not competent for the owners of land which is a part of a grant to a State under the Swamp Land Act, 9 Stat. 519, to set up in proceedings begun to enforce a tax on the land assessed under a State law for the purpose of draining and improving it that the State law impairs the obligation of the contract between the State and the United States and so violates the constitution; because (1), if the Swamp Land Act constituted a contract between the State and the United States, he was no party to it; and (2) the appropriation of the proceeds of the granted swamp lands rests solely in the good faith of the State."

Meaning of Decisions.

In the first decision quoted it is declared that the obligation of a State to reclaim the land rests upon the State alone, and that no trust is thereby attached to the land itself, but that the title to such land when obtained from the State is not affected by the manner in which the State might perform its duty to the Government.

In the second decision it is declared that the purchaser of State swamp lands is not a party to the contract between the State and the United States relating to reclamation, and that the appropriation of the proceeds from the granted swamp lands to reclamation rests solely upon the good faith of the State.

These decisions of the highest tribunal of the land set at rest the whole question as to the legal right of a State to now create a swamp land district and include within its boundaries reclaimed and unreclaimed land, and assess all the land so included for purposes of general reclamation, and clearly discloses the fact that the State possesses no such right.

This practically disposes of the proposition to abandon the policy of reclamation by districts, and substitutes for it a single reclamation system, embracing all of the lands, reclaimed and unreclaimed, in one general system.

Considerations of brevity forbid any further examination of the propositions which have been mooted in this paper. The present purpose will have been accomplished by calling attention to the fact that with the revival of the old abandoned theory of a general reclamation system or none, theories long since relegated to disuse by scientific inquiry are revived. For instance, the idea of the multiplicity of channels as a relief for maximum flood conditions is brought forward with all the complacency that would be manifested if the utter uselessness of that method was not far within the range of ascertained knowledge.

Engineer's Testimony.

James B. Eads, the distinguished hydraulic engineer, who

was brought to this State by the commissioners appointed under the Act of April 23, 1880, in an able and exhaustive report declared that the multiplication of channels reduced the drainage capacity of a stream. He showed that the division of the channel of a stream augmented the friction which resists a current, whereas confining the stream to a single adequate channel induced the formation of a hydraulic prism, which is the form insuring the maximum of flow with the minimum of friction.

The revival of past theories is accompanied by a proposition to construct what was known as the Montezuma canal. This means a canal from Greys Bend, above the mouth of Feather River on the Sacramento, through the Yolo-Solano Tule Basin and through a canal cut through the Montezuma Hills into Suisun Bay. This proposition underwent the most rigid engineering inquiry at the expense of the State and at the hands of Engineer Smith, whose experience as a hydraulic engineer was acquired in the service of the British Government in India when the national irrigation systems of that country were constructed. His report condemned the scheme as wholly impracticable. While the reasons for this conclusion were retained in the popular mind, the Montezuma canal was deemed an impossibility. Its specter rises as the invaluable literature relating to it is forgotten.

The propositions now brought forward are prompted by the most public-spirited and patriotic motives. From the standard of motive, they are worthy of the highest commendation. They are not amenable to the charge of having been mooted by individuals or any class of individuals, or pro-

moted by any special class of property owners, but they violate the maxim that the present must be a continuation of the settled principles and ascertained knowledge of the past if it is to have profitable continuity with the future. In the evolution of the policy of reclamation there is in existence a copious literature. In 1874, acting under the instruction of the government and in pursuance of joint resolution of Congress, the government engineers made a hydrographic survey of the State of California. This survey was conducted by Colonel Alexander, under whose immediate direction the data was compiled and the invaluable maps drawn. The report treated the whole subject of irrigation, reclamation and drainage. Its salient recommendation was the construction of a canal skirting the foothills between the mountains and the level land of the interior basin and the transfusion and equalization of the flow of all the affluents of the San Joaquin and Sacramento valleys.

The report of Engineer Smith with accompanying maps on the Montezuma Hills canal; the report of James B. Eads, special consulting engineer on the drainage of the Sacramento valley; the various reports of State Engineer William Hammond Hall and his assistant, C. E. Grunsky—these with the reports of the State swamp land commissions at various times have cost the State in the aggregate nearly \$500,000. It is a sad commentary on the method in which these costly instrumentalities of popular education have been preserved that their irrefragable conclusions are no longer a guide to public opinion.

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